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(54) Arrangement for Working an Internal Rotational Surface in A Cylindrical Cavity or Open-ended Passage Having a High Slenderness Ratio of A Metal Workpiece

(57) Arrangement for working an internal rotational surface in a cylindrical cavity or open-ended passage having a high slenderness ratio of a metal workpiece 9, using for working an electrode 14 connected to the negative pole of a source of impulses, the positive pole of which source is conductively connected with the workpiece. The electrode 14 is fixed conductively on a supporting tube 13, which is arranged rotatably and eccentrically in a cylindrical space inside sleeve 10 on which the workpiece is mounted. In the course of working the electrode or the workpiece rotates and the electrode performs an axial advance.

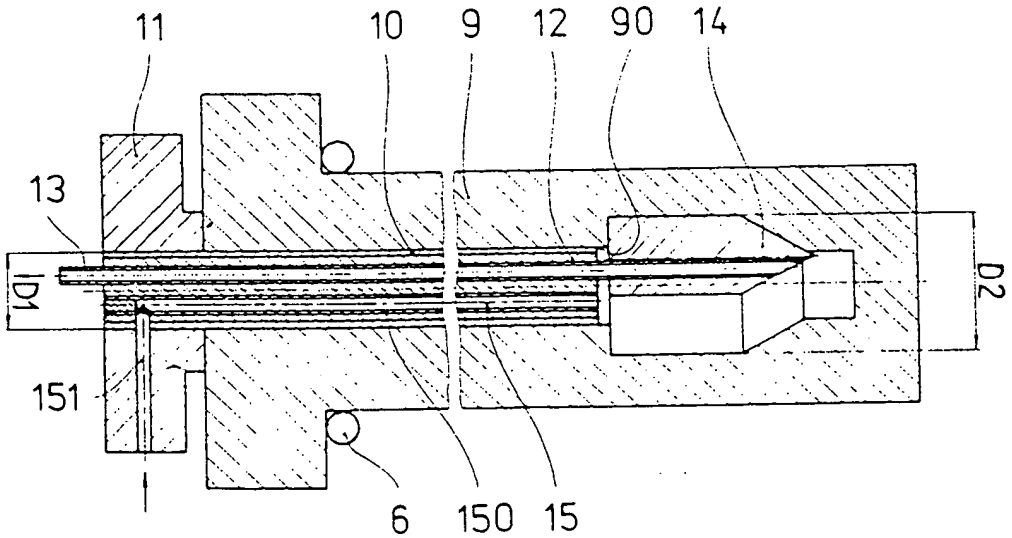

FIG. 1

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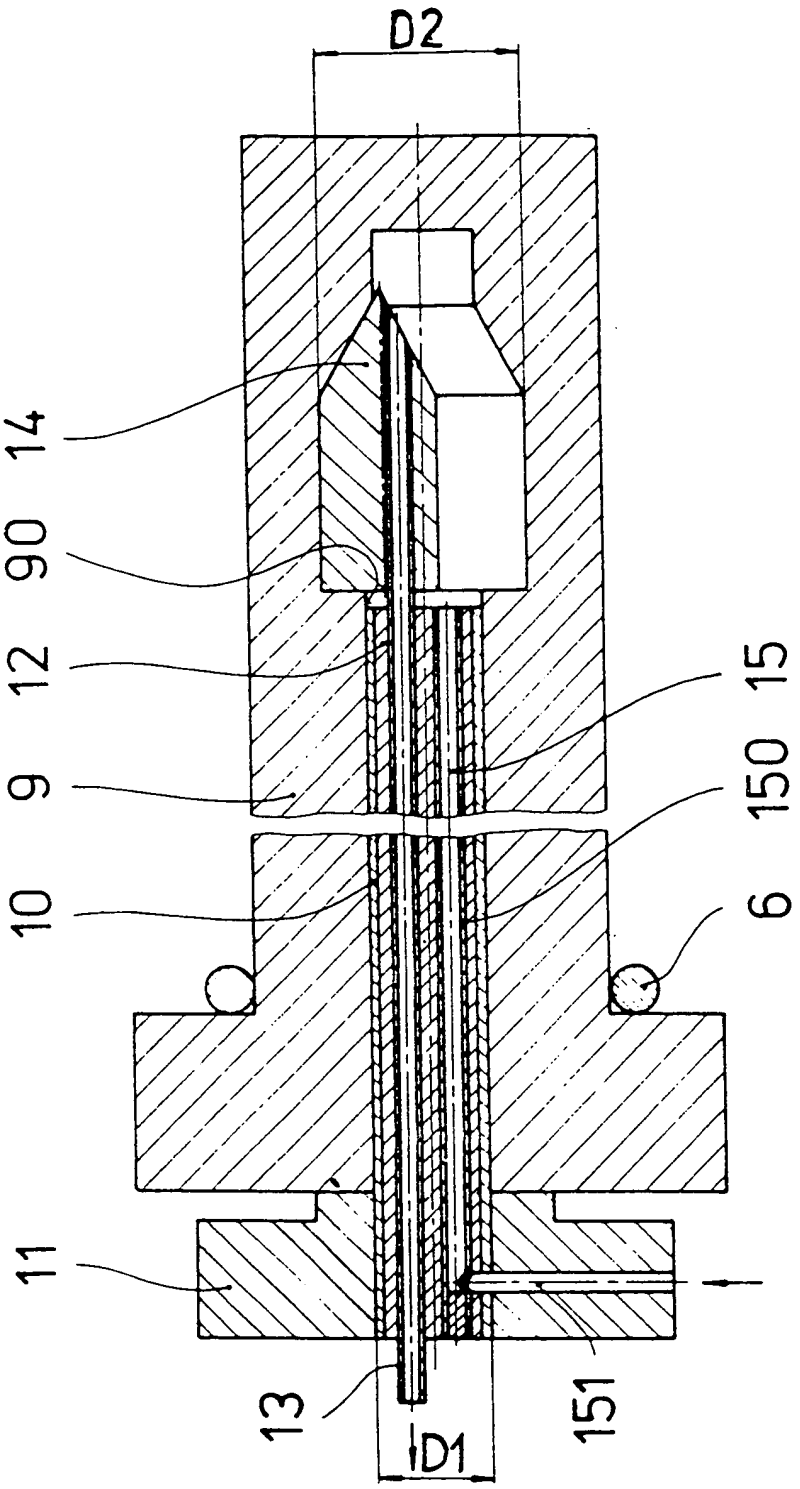

FIG. 1

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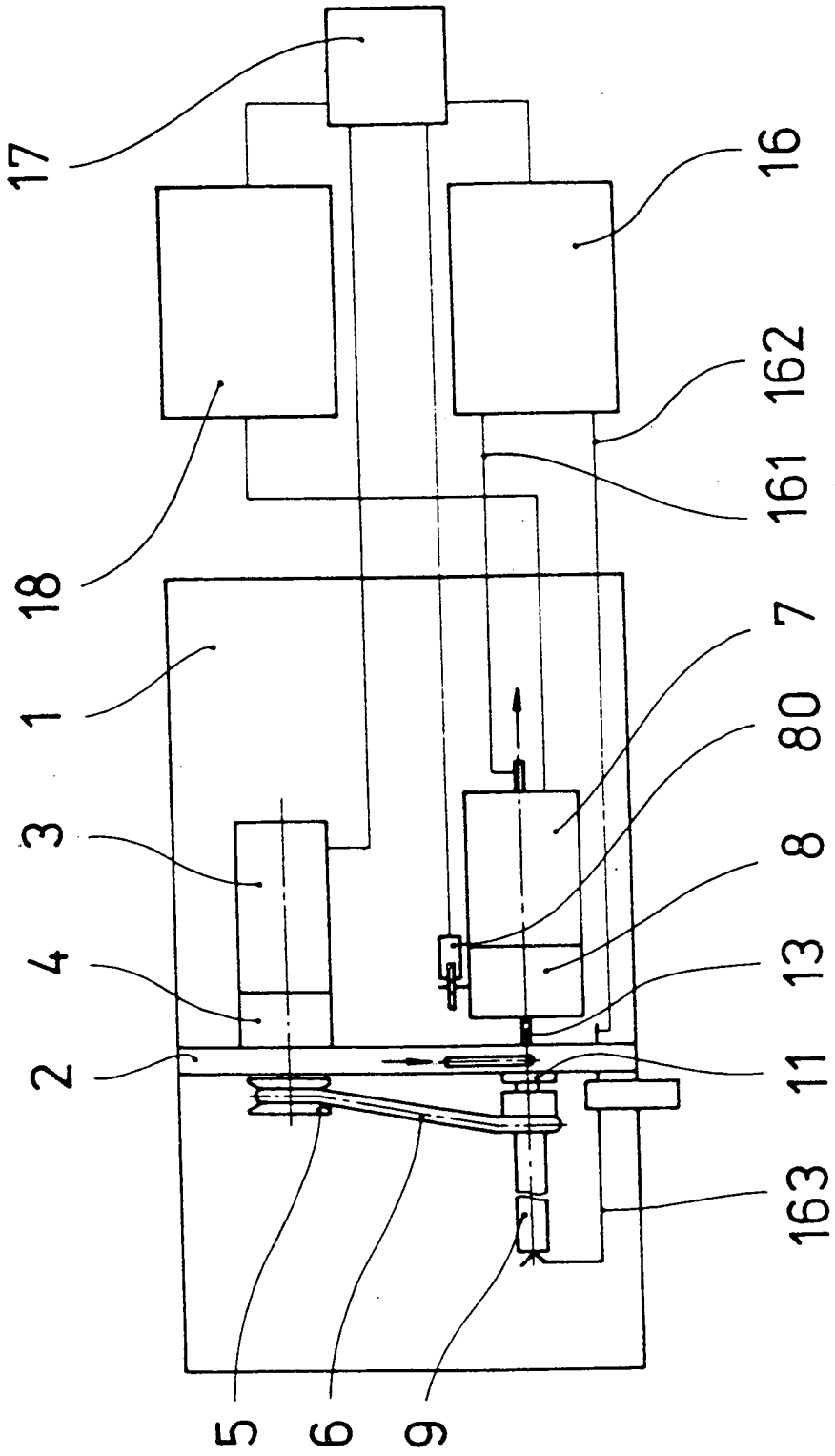

FIG. 2

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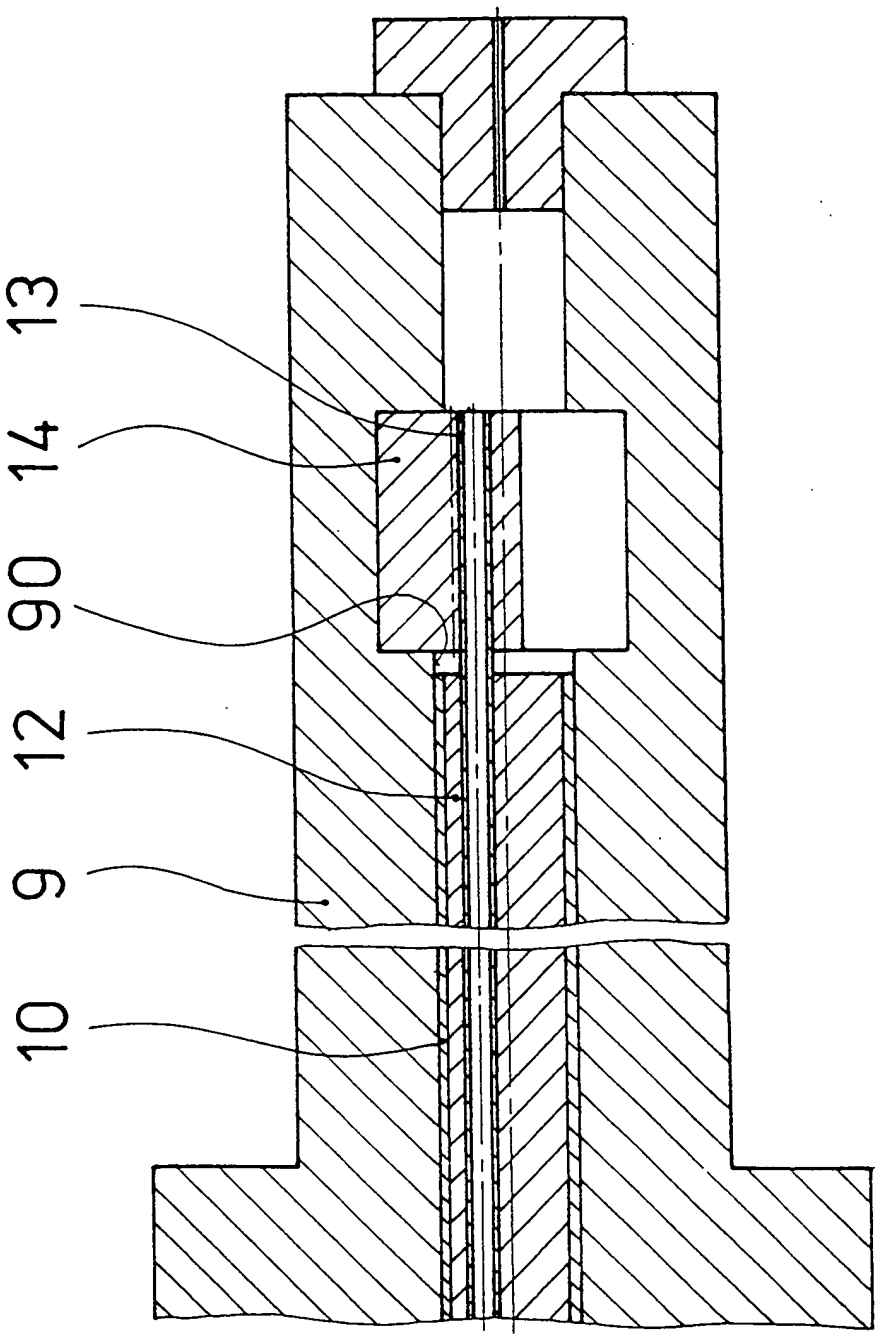

FIG. 3

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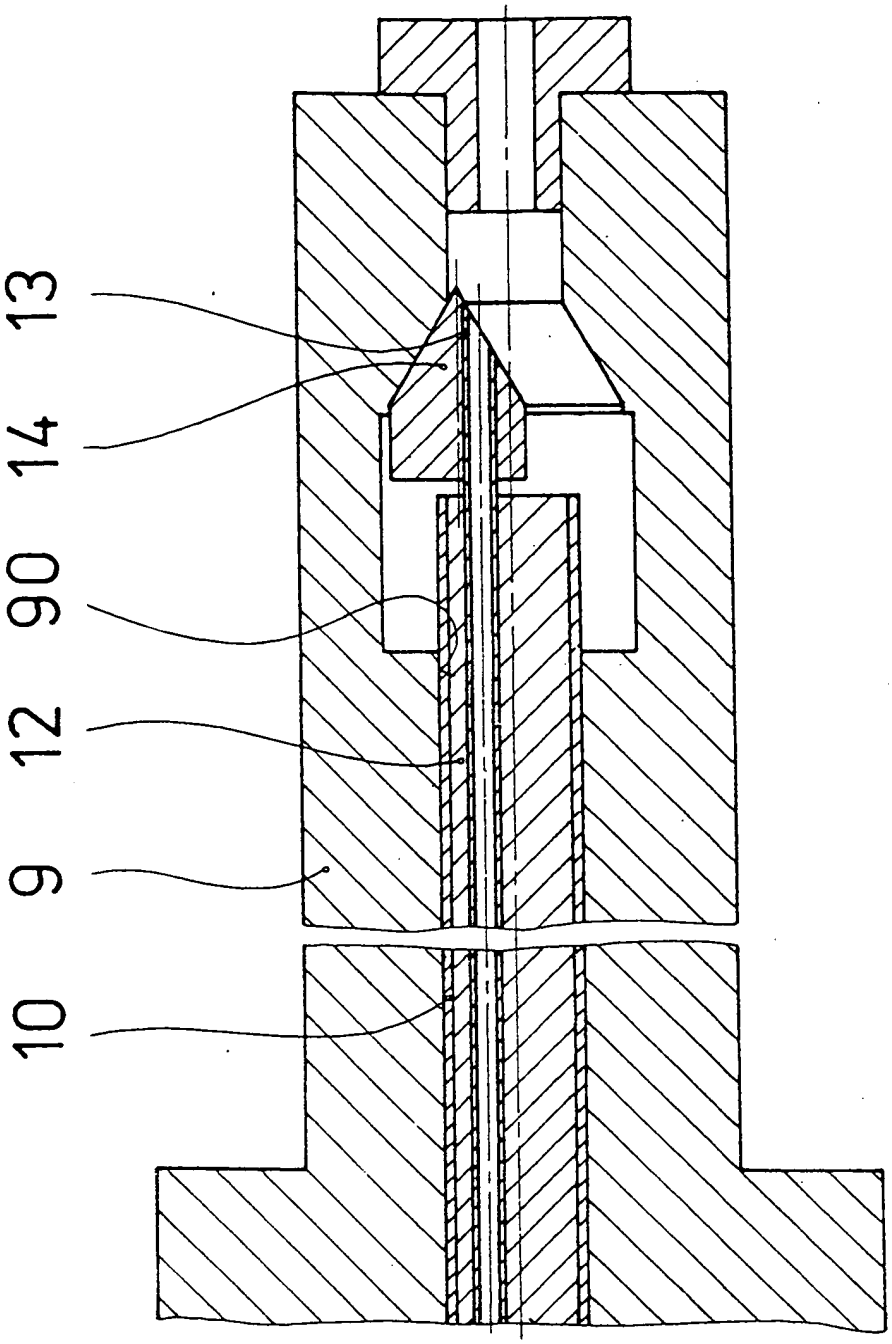

FIG. 4

SPECIFICATION

Arrangement for Working an Internal Rotational Surface in a Cylindrical Cavity or Open-ended Passage Having a High Slenderness Ratio of a Metal Workpiece

The invention relates to an arrangement for working an internal surface in a cylindrical cavity or open-ended passage having a high slenderness ratio of a metal workpiece, using for working an electrode connected to the negative pole of a source of burning impulses, the positive pole of which source is conductively connected with the workpiece.

The working of internal rotational surfaces—called also recessing surfaces—in cylindrical hollow spaces and open-ended passages of metal workpieces offers substantial difficulties if hollow spaces or passages with a high slenderness ratio are concerned, particularly if the absolute value of the diameter of the cylindrical hollow space or passage amounts to several millimeters, as is the case for instance in up to date injection nozzles of diesel engines and the like.

Working by turning is already difficult at a slenderness ratio D/L equal to 1/5, and cannot be practically applied in these present cases.

Working by grinding fails also at a slenderness ratio D/L equal to 1/8.

It is possible to work by electrolytical working internal rotational surfaces at relatively substantial depths. There are, however, drawbacks in that the worked surface is not accurate, the diameter and shape of the worked surface is rather dependent on the working time and a satisfactory coaxiality cannot be achieved. When working by the electrolytical method, a defective so called guiding diameter is usually the result, i.e. the diameter of the cylindrical surface, where the required rotaional surface is created, so that it is impossible to achieve a sharp edge at the junction between the guiding diameter and the worked surface.

A disadvantage of this working process is that remnants of the electrolyte can only be removed from deep openings with difficulty, causing further problems during subsequent processes and influencing the final quality of the product.

Another disadvantage is the labour intensive nature of these working methods.

According to the invention there is provided an arrangement for working an internal rotational surface in a cylindrical cavity or open-ended passage having a high slenderness ratio of a metal workpiece, using for working an electrode connected to the negative pole of a source of burning impulses the positive pole of which is conductively connected with the workpiece, the arrangement comprising a cylindrical guiding sleeve, a supporting tube and an electrode, the electrode fixed conductively on the supporting tube, said tube arranged rotatably and eccentrically in the cylindrical guiding sleeve, against which it is insulated, and the external diameter of which sleeve corresponding to the internal diameter of the cylindrical opening of the workpiece, whereby the outline of the electrode when viewed axially in its position for insertion is equal to or smaller than the outline of the cylindrical guiding sleeve.

A channel may be made terminating in the space where the electrode is arranged.

The cylindrical guiding sleeve can be provided with a holder on its end which is remote from the electrode.

The supporting tube and the channel can be connected to a rinsing arrangement.

Preferably the insulation between the cylindrical guiding sleeve and the supporting tube is formed by an insulating filling of the cylindrical guiding sleeve where the supporting tube is rotationally arranged. Also a channel may be provided in the insulating filling.

The arrangement according to the invention has a wide possibility of application, particularly on workpieces having a small guiding diameter as is the case for instance in up to date injectors of diesel engines, small hydraulic elements and the like.

The arrangement also enables the achievement of an accuracy larger than 1 micron so far as coaxiality circularity and roughness of the worked surface are concerned.

By way of example, specific embodiments according to the invention will be described with reference to the accompanying drawings in which:—

Figure 1 is a longitudinal axial section through the electrode, the cylindrical guiding sleeve and the workpiece of the arrangement of Figure 2;

Figure 2 is a plan view of the whole arrangement; and

Figures 3 and 4 are longitudinal axial sections of a workpiece to which two consecutive processes according to this invention have been applied.

Referring to Figures 1 and 2, a transverse plate 2 is fixed on a support 1. An electric motor 3 for generating the working drive is fixed to the plate 2 together with a gear case 4 and a pulley 5 encompassed by a belt 6, which in this embodiment is a rubber belt.

An electric motor 7 with a gear case 8 for rotary micro advance is also fixed on the support.

A metal workpiece 9, by its cylindrical cavity 90 with its so called guiding diameter D1, is shiftably mounted on a cylindrical guiding sleeve 10, which is fixed on a holder 11 secured to the transverse plate 2.

In order to generate the required rotational motion of the workpiece 9, the workpiece is encompassed by the rubber belt 6.

A supporting tube 13 is freely rotatably arranged within the cylindrical guiding sleeve 10 in an insulating filling 12. On the end of the supporting tube 13 an electrode 14 is eccentrically fixed, insulated against the cylindrical guiding sleeve 10. The supporting tube 13 is arranged eccentrically in the guiding sleeve 10.

The size of the electrode 14 is advantageously chosen so that when it is turned into the introductory position, i.e. into a position in which it is inserted together with the cylindrical guiding sleeve 10 into the cylindrical cavity 90 of the workpiece 9 to be worked, the external outline of the electrode when viewed axially is equal to or smaller than the outline of the cylindrical guiding sleeve 10.

The internal space of the guiding tube 13 is interconnected with the space where the electrode 14 is arranged.

The surface of the electrode 14 is prior worked so that in a certain eccentric position with respect to the guiding sleeve 10—for instance in the extreme position—its external outline corresponds to the outline of the rotational surface which has to be made in the respective place in the cylindrical cavity 90.

In arrangements designed for working internal rotational surfaces in a cylindrical cavity 90, a channel 15 terminating in the space where the electrode 14 is arranged is provided in the insulating filling 12. The channel 15 is formed by a tube 150 and a bore 151 in the holder 11.

The supporting tube 13 and the channel 15 are connected to a known rinsing arrangement (not shown), serving for the supply of a suitable liquid into the space where the electrode 14 is arranged and for removal of this liquid together with products originating in the course of burning of the electrode 14, from this space.

In arrangements designed for working internal rotational surfaces in an open-ended cylindrical passage, no channel 15 is required, as the liquid together with products originating in the course of burning of the electrode 14 are removed through the open-ended space in the workpiece 9.

The arrangement also comprises a source 16 of burning impulses, the negative pole of which is connected by a conductor 161 to the supporting tube 13 and thus also to the electrode 14. The positive pole of the source 16 is connected by a conductor 162 and by a resilient contact 163 with the workpiece 9.

The source 16 of burning impulses is controlled by an adjustable control device 17, to which also a regulator 18 of the electric motor 7 is connected. The regulator 18 enables in the course of the electro-erosive working to control the electric motor 7 in dependence on the voltage between the electrode 14 and the worked rotational surface.

The described arrangement operates as follows. The workpiece 9 to be worked is shifted on the cylindrical guiding sleeve at such a deviation of the electrode 14 which will enable the required shifting to be achieved.

The workpiece is then encompassed by the belt 6 and the electric motor 3 is started by the control device 17, whereby a rotational motion is transmitted to the workpiece 9 of the order about 600 to 1000rpm. The source 16 of burning impulses is agitated, the rinsing arrangement (not shown) and the electric motor 7 are started, which motor 7 by way of the gear case 8 turns by micro advance the electrode 14 which starts to work the respective surface on the principle of electroerosive working. The working proceeds until the required shape of the worked surface is acheived, whereafter the arrangement is stopped. The electrode 14 is turned into its initial position, the belt 6 is removed and the workpiece 9 is taken off from the cylindrical guiding sleeve 10, whereafter another workpiece 9 is shiftably mounted thereon and the described process is repeated.

The burning parameters are according to the required roughness of the worked surface optimally adjustable by the control device 17 and by a counter 80 with a micro switch.

In the embodiment shown in Figures 3 and 4 the process proceeds so that first an internal cylindrical recess as shown in Figure 3 is formed by means of a suitably shaped electrode 14, for instance by a cylindrical electrode (Figure 3). Another electrode 14 is then inserted into the thus formed internal cylindrical recess (Figure 4), is turned into the shown position and by axial micro advance of the electrode 14, obtained for instance by means described in the Czechoslovak Certificate of Authorship No. 170.857, with simultaneous rotation the required conical surface is subsequently burned out.

A process is also possible where the workpiece 9 rotates in the course of working and the electrode performs solely an axial micro advance.

If the maximum diameter of the worked rotational surface is D2, as indicated in Figure 2, it is possible to achieve by the arrangement according to this invention a ratio D2/D1 substantially within 5/3, where D1 is already above mentioned guiding diameter of the workpiece 9.

An advantage of the embodiments described above is that they enable an economic and very accurate working of rotational surfaces, particularly of cylindrical, conical—and also of other shapes—in a cylindrical cavity or open-ended passage having a high slenderness ratio, where the diameter of the rotational surface is larger than the so called guiding diameter, i.e. than the diameter of the cylindrical cavity or open-ended passage even if the dimension of the guiding diameter is about 1mm.

Claims

1. Arrangements for working an internal rotational surface in a cylindrical cavity or open-ended passage having a high slenderness ratio of a metal workpiece, using for working an electrode connected to the negative pole of a source of burning impulses, the positive pole of which is conductively connected with the workpiece, the arrangement comprising a cylindrical guiding sleeve, a supporting tube and an electrode, the electrode fixed conductively on the supporting tube, said tube arranged rotatably and eccentrically in the cylindrical guiding sleeve, against which it is insulated, and the external

diameter of which sleeve corresponding to the internal diameter of the cylindrical opening of the workpiece, whereby the outline of the electrode when viewed axially in its position for insertion is equal to or smaller than the outline of the cylindrical guiding sleeve.

2. Arrangement as claimed in claim 1, wherein the insulation between the cylindrical guiding sleeve and the supporting tube is provided by an insulating filling of the cylindrical guiding sleeve, and in which filling the supporting tube is rotatably arranged.

3. Arrangement as claimed in claim 2, wherein a channel is provided in the insulating filling.

4 Arrangement as claimed in claim 1, including a drive for the supporting tube and for a rotational micro advance of the electrode, and a working drive for the workpiece.

5. Arrangement for working an internal rotational surface in a cylindrical cavity or open-ended passage having a high slenderness ratio of a metal workpiece substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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